"Chroogloeocystis siderophila" - a potential model for cyanobacteria-mediated Precambrian iron transformations

Igor Brown
Astromaterial Research and Exploration Science
NASA Johnson Space Center (NRC)
Male code SA 13, NASA JSC, 2101 NASA Parkway, Houston TX 77058
USA
igor.i.brown1@jsc.nasa.gov

Daniel Mummey
Microbial Ecology Program, Division of Biological Sciences
University of Montana
USA

David S. McKay
Astromaterial Research and Exploration Science
NASA Johnson Space Center
USA

Precambrian cyanobacteria likely resided in aqueous environments characterized by physico-chemical conditions very different than what is typical today. Dissolved iron concentrations within Precambrian springs, rivers, lakes and oceans could have approached 100 mg kg^{-1}, levels significantly greater than all contemporary analogs excluding thermal springs and vents (Emerson, D. and Moyer, C. L., 2002; Papke, R. T., et al., 2003). Bacterial processing of this high Fe abundance was likely involved in the formation of many banded iron formations (BIFS).

Here we report the taxonomic and physiological characterization of a novel cyanobacterium recently isolated from the iron-depositing LaDuke hot spring in Great Yellowstone area. This isolate requires elevated iron concentrations for photosynthesis. The isolate absorbs significant amounts of ferrous iron from the culture medium and generates abundant fine-grained hematite. Our data is support the hypothesis of Y. Cohen (1989), who suggests that hematite might be generated within cyanobacterial cells and subsequently transported outward where it accumulates as fine-grained precipitates between cells.

The isolate was found to be phylogenetically, morphologically and physiologically distinct from any other described cyanobacterial genus. Therefore, the name "Chroogloeocystis siderophila" is proposed. The resemblance of the chemistry of the LaDuke collection environment to some proposed Precambrian surface waters (MacLeod, G. et al., 1994), and the novel physiological properties of this bacteria isolate suggest that it might provide a model system for the study of ancient iron-dependent prokaryotic physiology and environmental iron redox reactions and precipitation, as well as providing insights into cyanobacterial evolution and phylogenetic relationships.